PATENT SPECIFICATION

768,780

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COMPLETE SPECIFICATION

Method and Apparatus for Bending Glass

We, LIBBEY-OWENS-FORD Glass Company, a Corporation organized under the laws of the State of Ohio, of 608 Madison Avenue, City of Toledo, County of Lucas, and State of Ohio, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to an improved method and apparatus for bending glass sheets or plates.

In the bending of glass sheets, it is customary to support a flat sheet horizontally on a bending mold and then pass it through a furnace in which heat is applied to the sheet to soften the glass and cause it to settle into conformity with the shaping surface of the mold. In producing bends having segments with a relatively sharp curvature, it is necessary that a relatively greater heat concentration be applied to these portions so as to render them more pliable and therefore easily bent. In doing so, it has been found desirable to shield other selected portions of the glass sheet during its travel through the furnace. This shielding of certain portions of the glass sheet permits the remainder of the sheet to be brought to a higher temperature without raising the shielded portions of the glass to such temperatures and provides better control of the bending conditions so that those portions of the glass that are to be given a shallow curvature do not sag out of shape while relatively deep bends are made in other portions of the sheet.

Briefly stated, the present invention incorporates a special arrangement of shields in a bending furnace for shading portions of the glass sheet to be bent during its travel through the furnace, and novel means for mounting and supporting the shields.

Therefore, the principal object of this invention is to provide a novel and improved method and apparatus for bending glass sheets of plates.

Another object of the invention is the provision of a novel method of positioning radiation shields within a bending furnace so as to shade predetermined areas of the glass sheets to be bent.

Another object of the invention is to provide novel means within the bending furnace for adjustably supporting the radiation shields.

A further object of the invention is to provide a method of bending a sheet of glass into conformity with the shaping surface of a mold, comprising supporting the glass sheet to be bent in bending relation above the mold, passing the mold and sheet through a high temperature region that includes a source of radiant heat, shading an area of the glass sheet from the source of radiant heat, and then varying the area of the sheet shaded from the radiant heat.

In the accompanying drawings:

Fig. 1 is a side elevation view of a bending furnace;

Fig. 2 is a partial plan view taken substantially along line 2–2 of Fig. 1;

Fig. 3 is a transverse sectional view taken substantially along line 3–3 of Fig. 1;

Fig. 4 is a fragmentary elevation view of the shield supporting means taken substantially along line 4–4 of Fig. 3;

Fig. 5 is a perspective view of a radiation shield;

Fig. 6 is a fragmentary plan view taken substantially along line 6–6 of Fig. 4; and

Fig. 7 is a transverse sectional view taken substantially along line 7–7 of Fig. 1.

With reference now to the drawings, it is to be understood that the present invention is by no means restricted for use with any particular design of bending furnace. However, there is disclosed in Fig. 1 of the drawings a conventional type of continuous glass bending

[*Price 3s. 0d.*]

furnace 10 and its allied components. Bending molds, each having a glass sheet carried thereon, are started through the furnace at the charge end 11 from which they pass into the bending section 12 with which this invention is primarily concerned. While passing through the bending section, the glass sheets, under the combined action of heat and gravity, settle into conformity with the shaping surface of the mold. After leaving the bending section 12, the sheets pass through the annealing portion 13 where the temperature of the glass is gradually lowered to room temperature at which time the sheets are removed at the delivery end 14 of the furnace.

As seen in Figs. 3 and 7, the furnace bending section 12 is substantially tunnel-like in cross-section having a roof portion 15, opposite side walls 16, and a bottom wall 17 all lined with a suitable heat resisting refractory.

The heat source within the bending section comprises upper radiant tubes 18 adjacent to but spaced downwardly from the roof 15, and lower radiant tubes 19 located beneath a conveyor 20 and above the bottom wall 17. These radiant tubes may be gas fired and the larger portion of the developed furnace heat is transferred by radiation. In use, the glass bending mold having supported thereon a glass sheet 21 to be bent, shown in Figs. 3 and 7 by phantom lines, is carried through the furnace on the conveyor 20 which may consist of a series of transversely disposed rollers 22 each having on the one end thereof a sprocket 23 which engages a power driven continuous chain in the usual manner.

It will be readily understood by those well versed in the art, that an object in a heated atmosphere will receive additional heat if it is exposed to a source of radiant heat. Therefore, if the glass sheets 21 were entirely shaded from the upper radiant tubes 18 by means of heat deflectors or radiation shields 24, it would receive heat from the furnace atmosphere and also radiant heat from the lower radiant tubes 19 and those portions of the refractory walls that could "see" the sheet. If a portion of the sheet 21 were left unshaded from the upper tube 18, that portion would receive additional heat in the form of radiation from these tubes and therefore would be at a higher temperature than the shaded portions.

Now, the novel method herein disclosed for bending glass sheets involves, essentially, the varying of the shaded portions of a glass sheet both as to the position of the shaded area on the sheet surface and the size of the shaded area.

More specifically, it is important that portions of the glass which are to remain relatively flat do not receive as much heat as the portions requiring more severe bends and yet, these relatively flat portions must absorb sufficient heat to bend in their required shape. There is illustrated here a special shielding arrangement that has been found to be particularly desirable in bending glass sheets of the general contour shown in broken lines in Fig. 7. As seen in Fig. 2, the shields 24 at the entry end *A* of the bending section 12 are alternately spaced on opposite sides of the furnace center line in a gradually narrowing pattern and then blended into a series of shields of gradually increasing width along the center line. With the shields thus positioned, the glass sheet 21 to be bent as it enters the bending section 12, has a portion thereof on each side of its center line shaded from the tubes 18, then exposed to radiant heat, then a part of each portion shaded, and finally the central portion of the sheet passes beneath the series of shields having successively greater widths so that a central portion of the sheet is shaded and the area of that portion increases as the sheet passes through the bending section. Since the central portion *a* of the sheet is only required to assume a shallow curvature, the shields shade that portion while the end portions *b*, which have a relatively sharper curvature, receive radiant heat from the tubes 18 throughout the sheet's passage through the bending section 12 thereby receiving the additional heat necessary for proper softening so as to enable them to assume the relatively sharper curvature. This novel spacing and sizing of the shields provides an incremental shading of selected portions of the glass sheet passing thereunder that enables an accurate control of temperature in the portions of the sheet to be bent.

As a further control of radiated heat from the upper radiant tubes 18, the shields 24 beginning at the furnace entry end *A* are in vertical descending spaced relationship with the glass sheet 21; that is, it is desirable that as the glass sheet approaches the area *B* within the furnace wherein the final bending is accomplished that the radiation shields are placed as close as is practical to the surface of the glass sheet giving therefore an accurate shading of the portions not requiring the additional heat of radiation. It is easily visualized that spacing the shields in close relationship with the glass (Fig. 7) provides a closer control of the line of separation between the shaded and unshaded portions of the glass sheet, and although this is not quite as important near the entry end *A* where the glass sheet is preheated, it is preferable in the furnace area *B* where final bending occurs because of the necessity of accurately concentrating heat in that area.

As a means of easily and accurately positioning the shields, the present invention provides a novel supporting framework that facilitates both transverse and vertical movement of shields within a furnace. Thus, the

shields 24 seen in Figs. 3 and 7 are carried on an adjustable supporting framework depending from the roof 15 of the bending section. More specifically, the shield has hook-shaped carrying members 25 (Fig. 4), the end portions of which are bent outwardly and down thereby forming an inverted U-shaped portion 26 which slidably engages a lip, portion 27 of a transversely disposed angular supporting member 28 carried by substantially vertical rods 29 extending through the roof 15 of the furnace and indirectly supported by the metallic casing plate 30 thereof.

As seen in Figs. 4 and 6, the angular members 28 are spaced back-to-back on opposite sides of the hanger rod 29, their bottom portions 31 being weldably joined to a flange 32 carried by the rod end, and their top edges restrained by ties 33. The rod end 34 opposite the flange 32 is passed through a sleeve 35 weldably connected to a flange plate 36 carried by the furnace roof plate 30, and the rod portion 37 housed within the sleeve 35 had a series of slots 38 formed therein and spaced from the end 34. To support the rod 29, a pin 39 is passed through one of the slots 38, the end portions of said pin being supported by the upper edge 40 of the sleeve 35.

Since the shields are relatively close to the glass in the portion of the furnace where final bending takes place and sharp changes in temperature between adjacent portions of the glass should be avoided, the edges of the shields that are parallel to the path of movement of the glass are serrated forming generally triangular teeth 41 (Fig. 5) which widen the zone between the completely shaded and the completely exposed areas of the glass thus minimizing the abruptness of the temperature differential between these adjacent portions. The teeth 41 are symmetrically located along both edges of the deflectors so that in the event a larger width must be shaded, two or more of the shields in transversely parallel relationship may be supported by a pair of members 28 and then pushed together with the teeth of one meshing with the teeth of the other.

In a furnace of this type, it is desirable that the shields be easily adjusted so as to position them for differently sized sheets, or bends, in successive production runs. For vertical adjustment, the rods 29 having the shield supporting members carried thereon are either raised or lowered, whichever is desirable, within the sleeves 35. Placing the pin 39 in the slot 38 closest above the upper edge of the sleeve supports the rod in place. For transverse adjustment of the shields, a hook 42 having a curved portion 43 on the one end thereof is passed through a bulkhead 44 formed in the furnace side wall and engages a dowel 45 formed between adjacent teeth 41 in the shield 24. Pushing or pulling on the hook 42 having engaged thereon a shield shifts the shield transversely within the furnace by sliding the shield carrying members 25 along the lip portion 27 of the transverse supporting members 28. If it is desired that end portions of a glass sheet passing through the furnace receive more heat than the central portion, the shields may be shifted toward the furnace center line. Conversely, if it is desirable to shield the end portions of a glass sheet, the shields are each shifted transversely away from the center line, thereby exposing the central portion of the glass sheet to the heat rays emitted from the radiant tubes 18.

Although the foregoing disclosure and drawings show the radiation shields disposed over the glass sheet so as to shield portions thereof from the upper tubes 18, it will be noted that the shields could be placed beneath the glass sheet to intercept portions of the radiation from the lower radiant tubes 19 and still function satisfactorily.

What we claim is:—

1. A method of bending a sheet of glass into conformity with the shaping surface of a mold, comprising supporting the glass sheet to be bent in bending relation above the mold, passing the mold and sheet through a high temperature region that includes a source of radiant heat, shading an area of the glass sheet from the source of radiant heat, and then progressively varying the area of the sheet shaded from the radiant heat as the mold travels through the furnace.

2. A method of bending a sheet of glass into conformity with the shaping surface of a mold as claimed in claim 1, including gradually increasing the area of the sheet which is shaded transversely with respect to its path of movement.

3. A method of bending a sheet of glass into conformity with the shaping surface of a mold as claimed in claim 1, in which the shading of the initial area of the glass sheet is discontinued as the sheet moves forwardly, after which a part only of said initially shaded area is again shaded from the radiant heat.

4. A method of bending a sheet of glass into conformity with the shaping surface of a mold as claimed in claim 1, in which different areas of the sheet transversely of the direction of travel of said sheet are shaded from the radiant heat during such travel through the first part of the heating chamber, after which the sheet is shaded along the central area thereof during its travel through the remainder of the heating chamber.

5. A method of bending a sheet of glass into conformity with the shaping surface of a mold as claimed in claim 4, in which the shading of the central area of the sheet during travel through the remainder of the chamber is gradually increased transversely of its path of movement.

6. A method of bending a sheet of glass into conformity with the shaping surface of a mold as claimed in claim 1, in which the initially shaded areas of the sheet are shaded from the radiant heat intermittently and stepwise inwardly from the ends thereof during movement of the sheet through the first part of the heating chamber, after which said sheet is shaded along the central portion thereof and substantially equidistantly from the center line of the sheet throughout the remainder of its travel through the heating chamber.

7. In equipment for bending glass sheets, in combination, a heating chamber, a heat source within the chamber, a conveyor for carrying molds bearing glass sheets to be bent through the chamber, vertically adjustable supporting means between the heat source and the path of the glass within the chamber, and heat deflector means mounted on said adjustable supporting means for shielding selected portions of the sheets from the heat source as they pass through the heating chamber.

8. In equipment for bending glass sheets as claimed in claim 7, wherein the adjustable supporting means includes means for adjusting the heat deflector means transversely of the heating chamber.

9. In equipment for bending glass sheets, in combination, a heating chamber, a heat source within the chamber, a conveyor for carrying molds bearing glass sheets to be bent through the chamber, adjustable supporting means between the heat source and the path of the glass within the chamber, and a plurality of heat deflectors of different sizes carried by said support means and disposed between the heat source and the path of travel of the glass within the heating chamber.

10. In equipment for bending glass sheets, in combination, a heating chamber, a heat source within the chamber, a conveyor for carrying molds bearing glass sheets to be bent through the chamber, adjustable supporting means between the heat source and the path of the glass within the chamber, and heat deflectors carried by said supporting means at different levels within the furnace and disposed between the heat source and the path of travel of the glass within the heating chamber.

11. In equipment for bending glass sheets, in combination, a heating chamber, a heat source within the chamber, a conveyor for carrying molds bearing glass sheets to be bent through the chamber, adjustable supporting means between the heat source and the path of the glass within the chamber, and a plurality of heat deflectors carried by said supporting means and arranged in transversely staggered relationship with one another along the path of travel of the glass sheets and disposed between the heat source and the path of travel of the glass within the heating chamber.

12. A method of bending a sheet of glass into conformity with the shaping surface of a mold substantially as described.

13. Equipment for bending glass sheets substantially as described with reference to the accompanying drawings.

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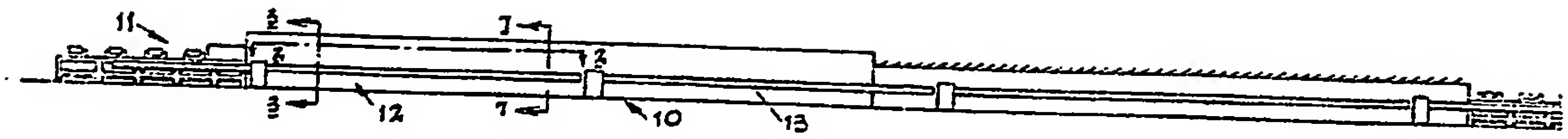

Fig. 1

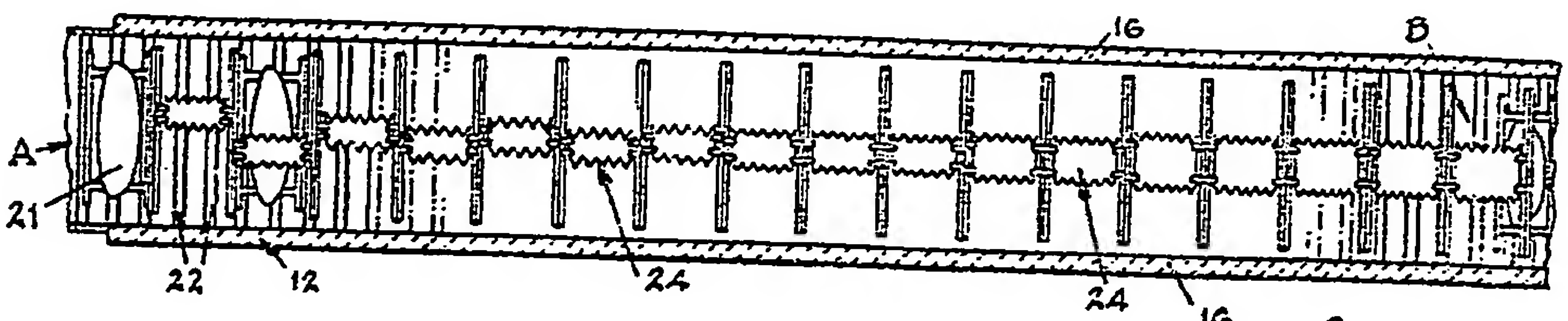

Fig. 2

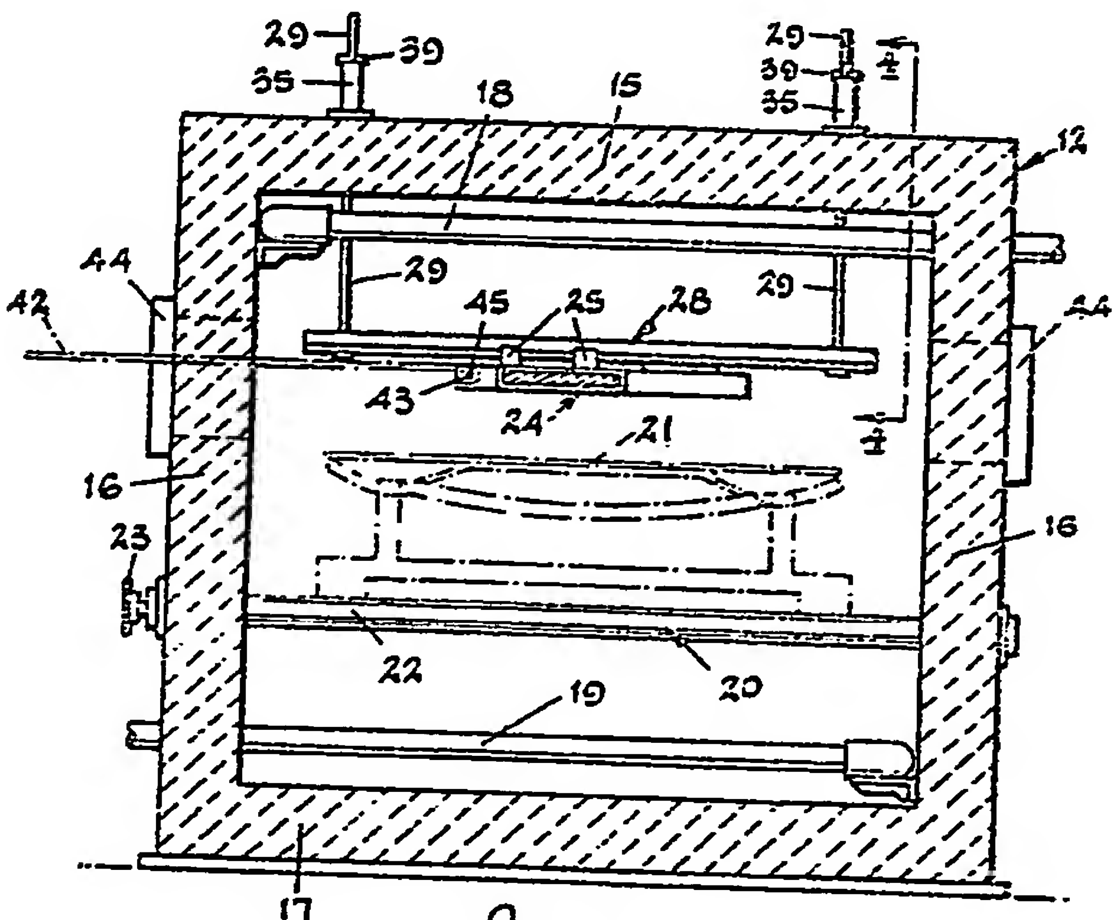

Fig. 3

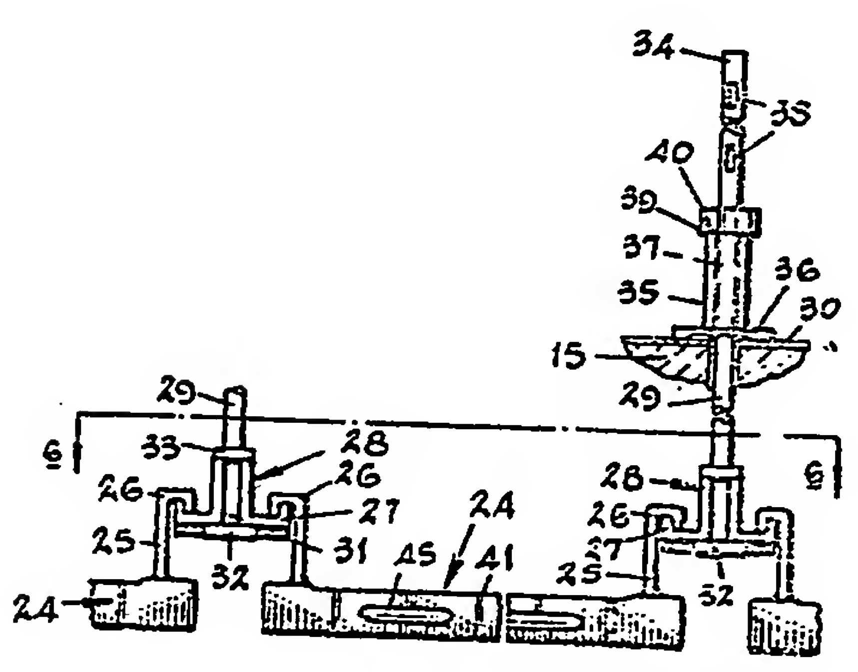

Fig. 4

768,780 COMPLETE SPECIFICATION
1 SHEET
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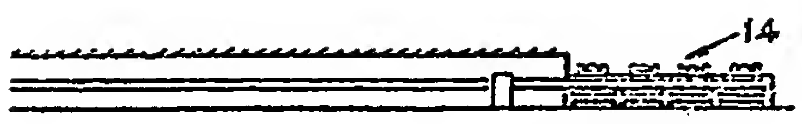

Fig. 1

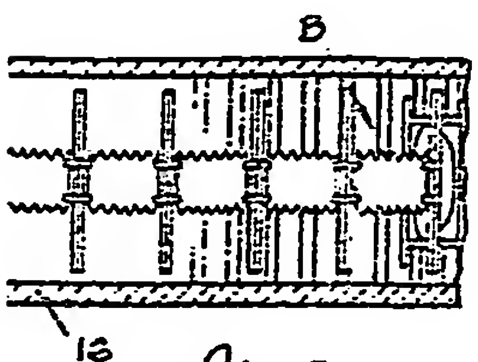

Fig. 2

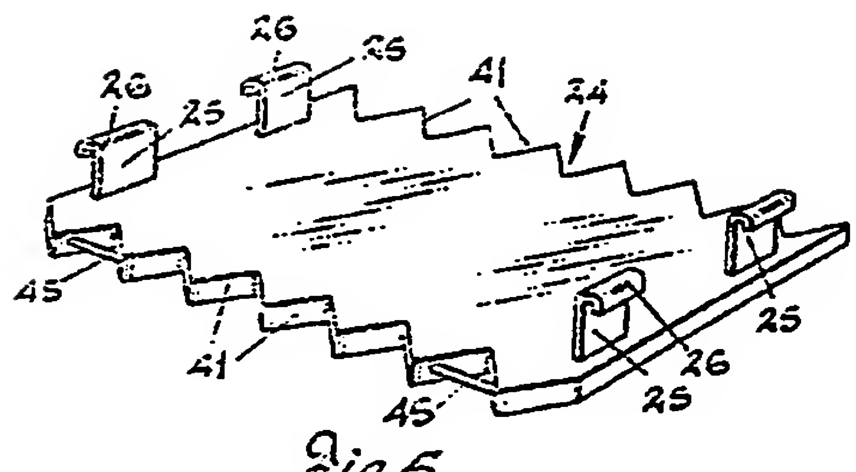

Fig. 5

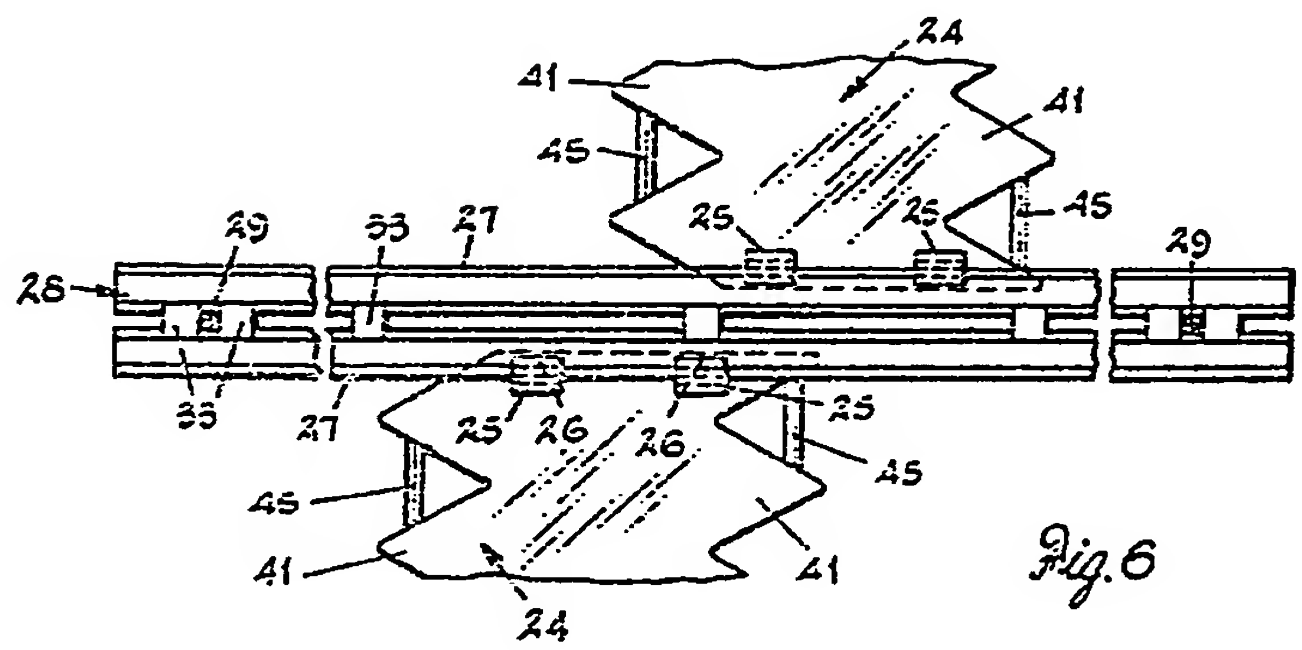

Fig. 6

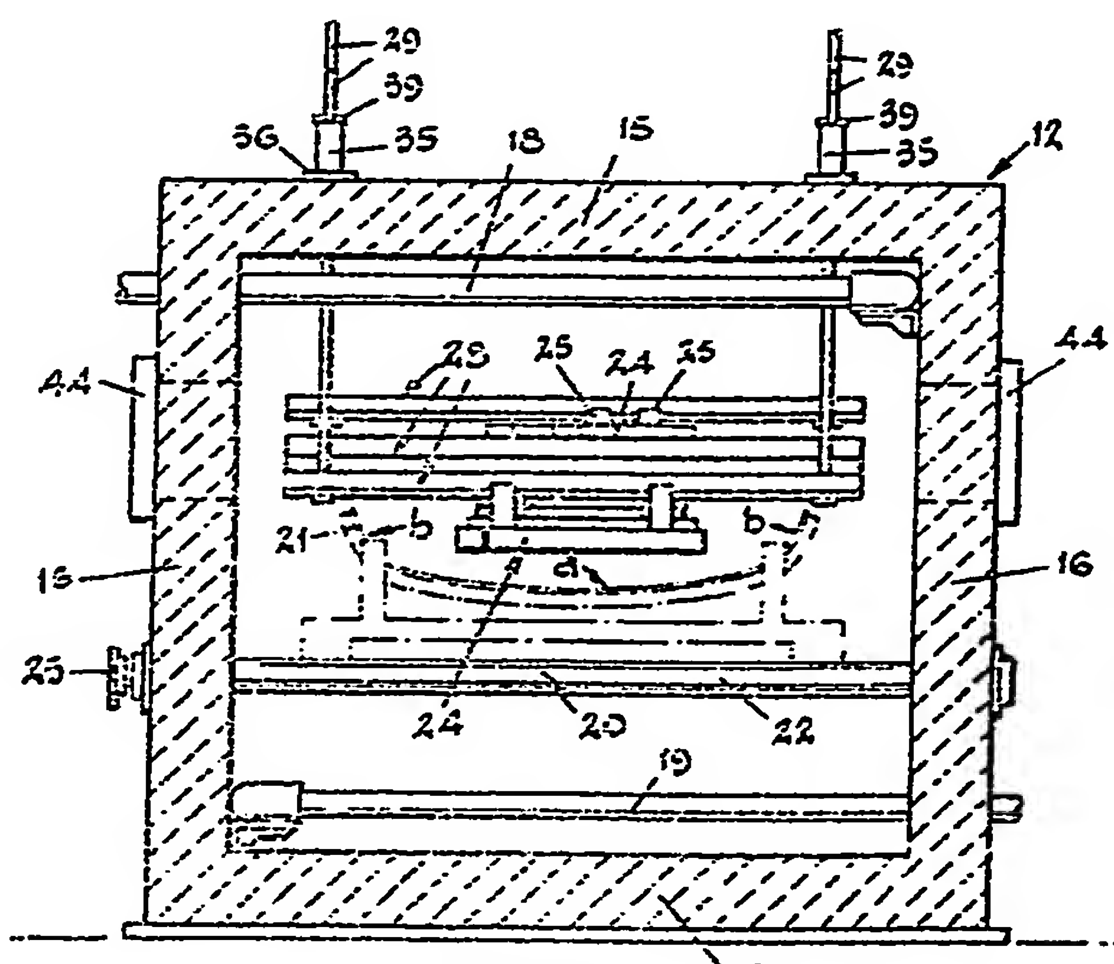

Fig. 7

768,780 COMPLETE SPECIFICATION
1 SHEET

This drawing is a reproduction of the Original on a reduced scale.

Fig. 1

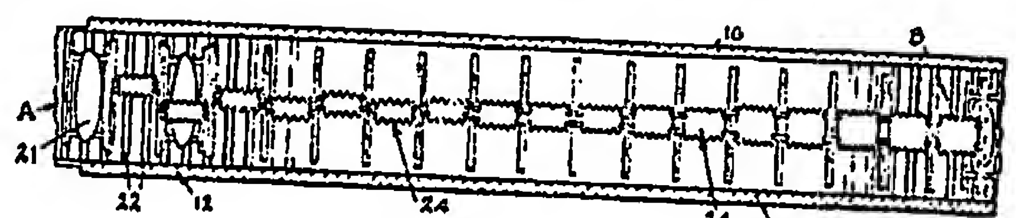

Fig. 2

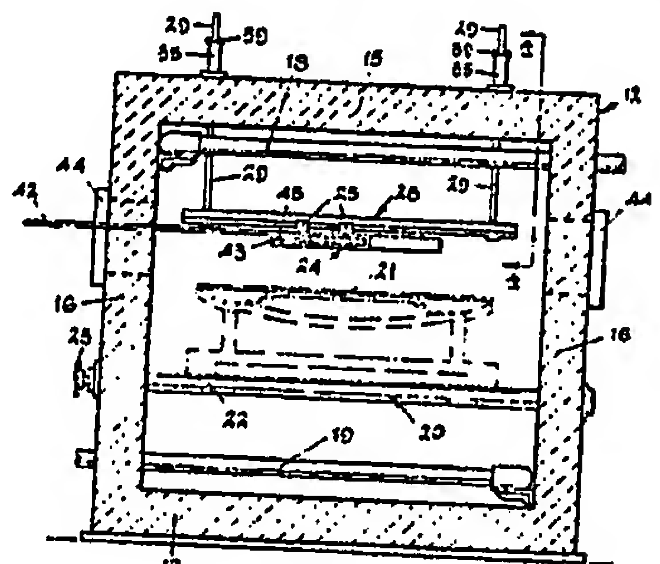

Fig. 3

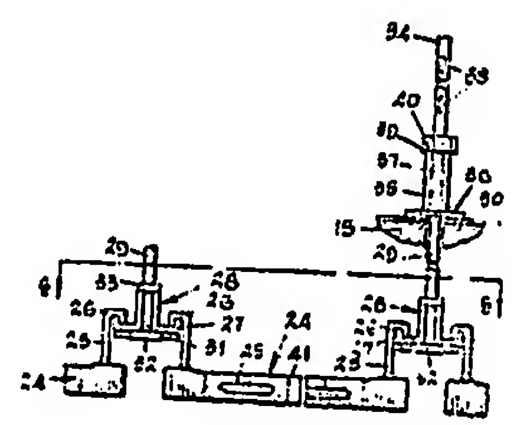

Fig. 4

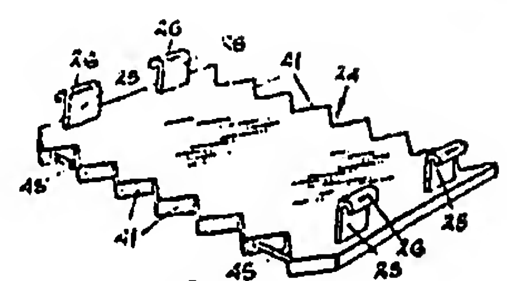

Fig. 5

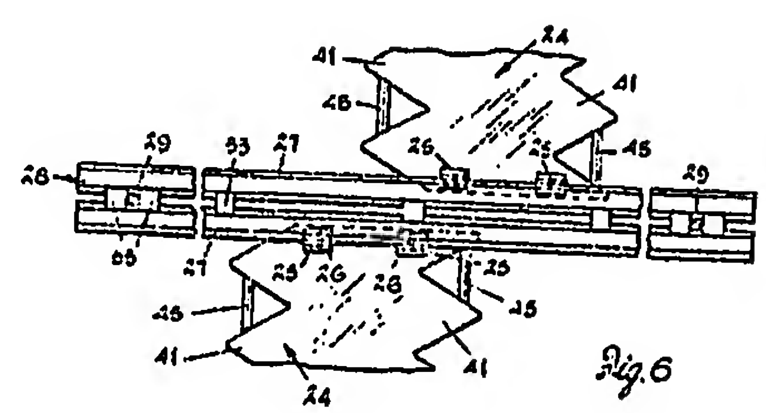

Fig. 6

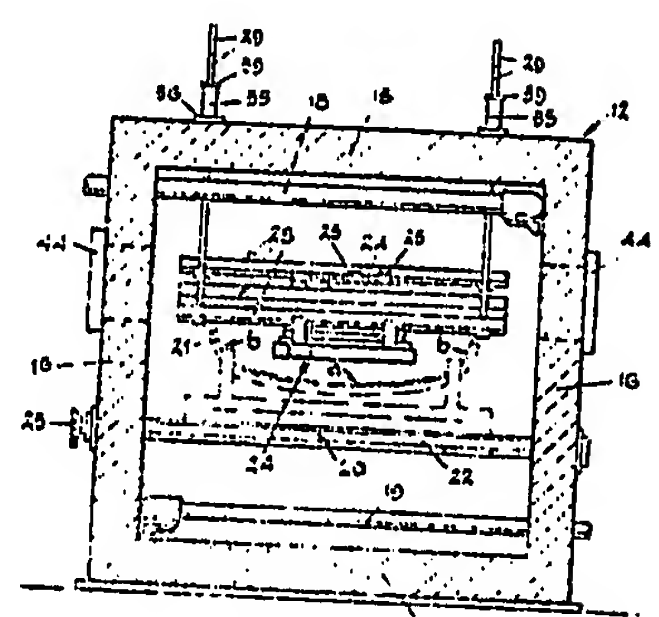

Fig. 7